Vinyl PCB Resist

Written By: Chris Connors

🔧 TOOLS:

- CNC vinyl cutter/plotter (1)
- Gloves (1)
- Safety glasses (1)
- Tray or jar (1)
  such as glass or ceramic
- Tweezers or other sharp tool (1)
  like a hobby knife, utility knife, or pushpin for "weeding" vinyl stickers

⚙ PARTS:

- Adhesive-backed vinyl sheets (1)
  if you don't have a vinyl cutter, send your design to a sign-making service or custom sticker company.
- Copper circuit board blank (1)
- Kitchen scrub pad, sandpaper, or steel wool (1)
  for scuffing the copper
- Masking tape or transfer tape (1)
  or similar low-tack tape
- Etching chemicals (1)
  such as ferric chloride, or muriatic (hydrochloric) acid with hydrogen peroxide

SUMMARY

There are lots of ways to etch a circuit board, but all of them create a path for electricity by preserving and removing portions of the copper coating on the board. You might have tried drawing a circuit on copper with a pen or grease pencil, or silk-screening it, or transferring toner from a laser printer, and then chemically etching the board. A substance used in this way is called a resist because it resists the etchant and protects the copper.

One of the easiest and most reliable resists I've found is adhesive-backed vinyl produced on a sign cutter. This is done by sticking your circuit trace image directly onto the board, and then immersing the board in a chemical bath. The exposed copper is removed, leaving just

the copper traces you want for your circuit. Here's how I do it.

Step 1 — Get a circuit board design.
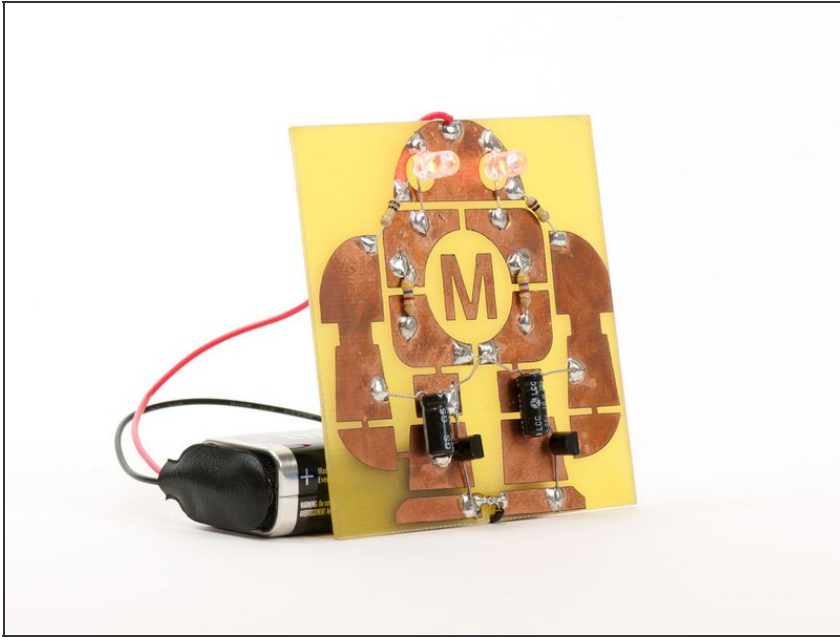
- You can design your own circuit traces, or use existing artwork of proven designs. Search the Open Circuits wiki, Adafruit's Github repository, and hobbyist websites like diystompboxes.com to get a taste of what's out there for free.
- And remember, you can also transform schematic diagrams into circuit board layouts using free software tools.
- We designed this board as a supersized version of the MAKE Learn to Solder robot pin. It's got huge traces, but people also use this method to make fine traces.

## Step 2 — Cut your design in vinyl.

- Convert your board design into an image format your vinyl cutter can use. If you bring the design to a shop, they'll tell you what formats to use.
- Cut the design into the vinyl with the vinyl cutter. If you're using a service, make sure the cut is scaled accurately. If the design isn't the right size, your parts may not fit properly.

Step 3 — "Weed" your vinyl stickers.
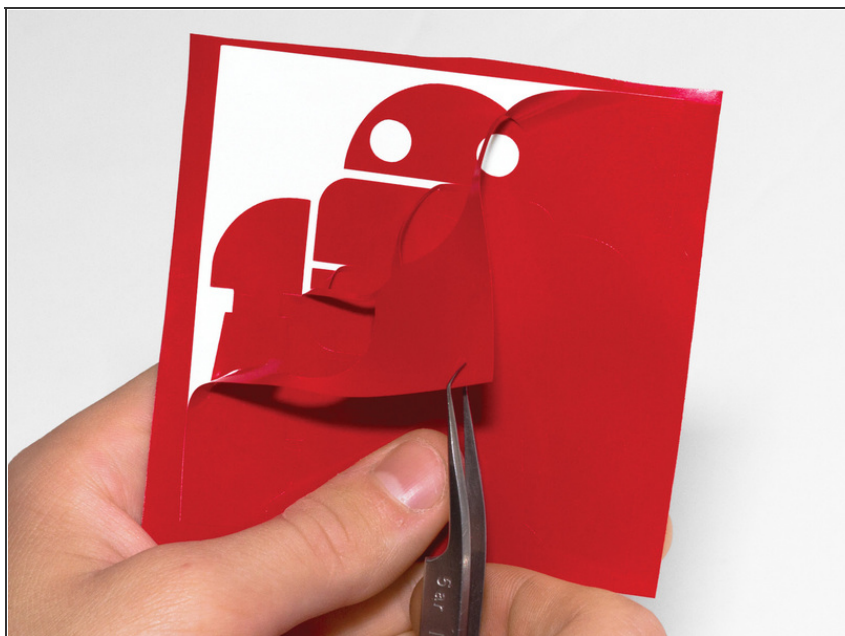
- Carefully remove the unwanted vinyl bits where you want the copper stripped from the board. Leave behind the parts where you want to protect the copper.

- Some services will weed the sticker for you; others may not. When we ordered some from TAP Plastics, they came back weeded.

- Most vinyl cutters come with fancy, sharp tweezers, but you can use a utility knife or a pushpin taped into the barrel of an old pen to pick out the parts of the vinyl you don't want.

- **IMPORTANT:** Double-check that your design is the right size, and that you left all the correct parts on the sticker when you weeded it!

## Step 4 — Transfer the vinyl to the copper board.
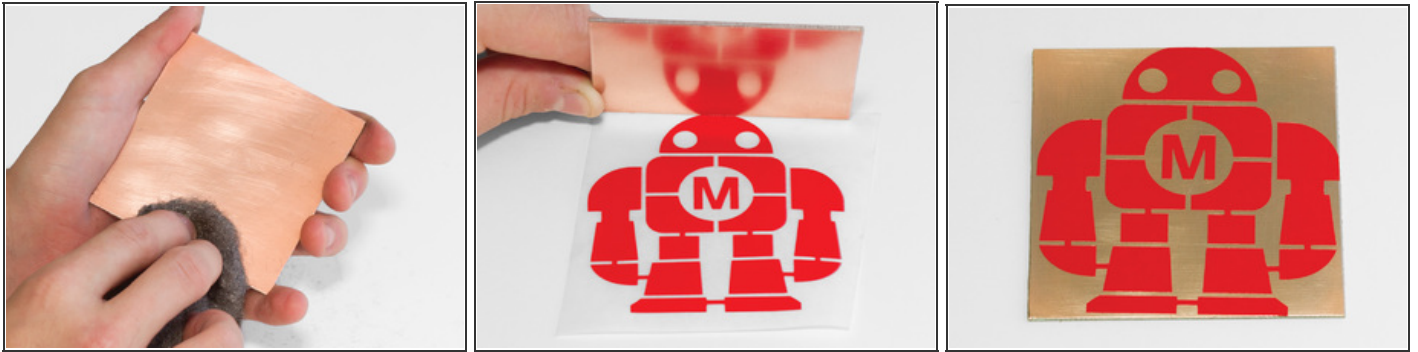
- Scuff the board so the etchant will be able to reach the copper easily. Circuit board blanks are treated with a clear coating that keeps the copper from oxidizing in the air. If this coating has been removed for any amount of time, you'll see dark spots. These spots shouldn't affect your etching.

- Place your weeded sticker on a flat surface and cover it with low-tack transfer tape or masking tape. If you use very sticky tape, the vinyl won't stay on your circuit board.

- Use the transfer tape to lift your vinyl sticker off its backing and place it onto the copper face of the board. Smooth it down firmly everywhere to get the best adhesion you can. Then remove the transfer tape.

Step 5 — Prepare the etchant bath.

- Put your etchant into a nonmetallic tray or jar with a tight-fitting lid.

- Wear safety goggles and rubber or vinyl gloves, to keep the etchant chemicals out of your eyes and off your skin.

- Most people use ferric chloride. Other chemicals will also work, such as muriatic (hydrochloric) acid and hydrogen peroxide. For detailed tutorials on both methods check out MAKE's Circuit Skills: Circuit Board Etching video and The Real Elliot's tutorial on Instructables.

Step 6 — Etch the circuit board.
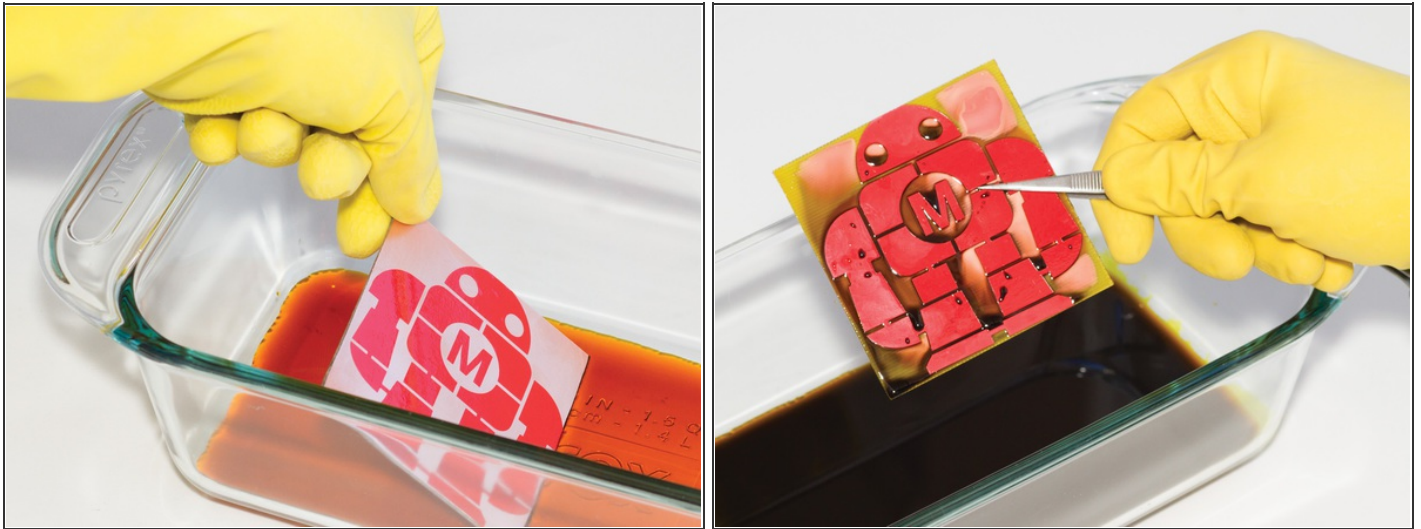
- Immerse the circuit board in the bath of etchant. Agitate the board from time to time, to keep fresh etchant working on the copper.

- Remove the board frequently to check its progress. If you etch for too long, you could etch away the circuit traces. However, over-etching is much less likely with this technique, since the vinyl makes a very tight bond with the board.

- It's done when the copper is completely removed from the areas not covered by vinyl. Take the board out of the etchant and rinse it under cold running water.

  - Using a smaller container will help you to use less liquid and still cover the board.

  - If your etching liquid is warm, it will act faster on the copper, reducing your etching time. You can prepare a warming tray filled with hot water, and place your etching tray or jar in it to raise the temperature. Make sure you don't overheat it.

  - If you etch in a small jar, you can seal the lid and shake it gently to agitate it with less risk of spilling.

Step 7 — Peel the vinyl off.
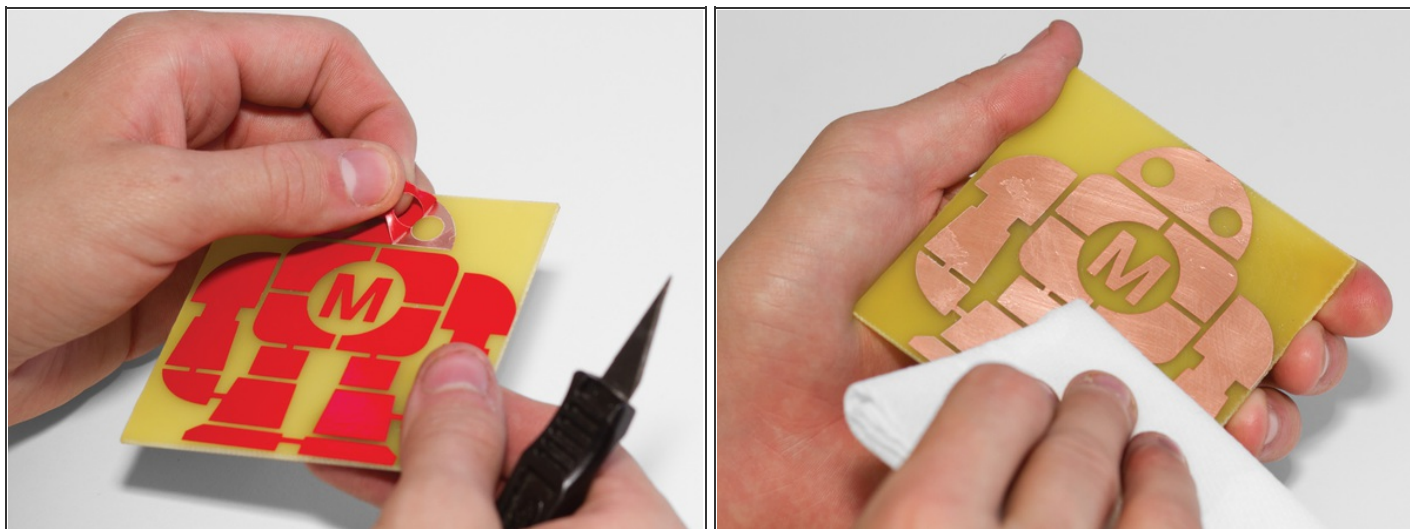
- Once you're sure the copper is cleared to your satisfaction, peel the vinyl resist off the board. It should come off easily.

- If you really need to etch it some more, you can, but placing the vinyl back on may be a challenge. It's best to leave the vinyl on until you're sure the copper is removed.

- Admire your new circuit board.

Step 8 — Use your new circuit board.
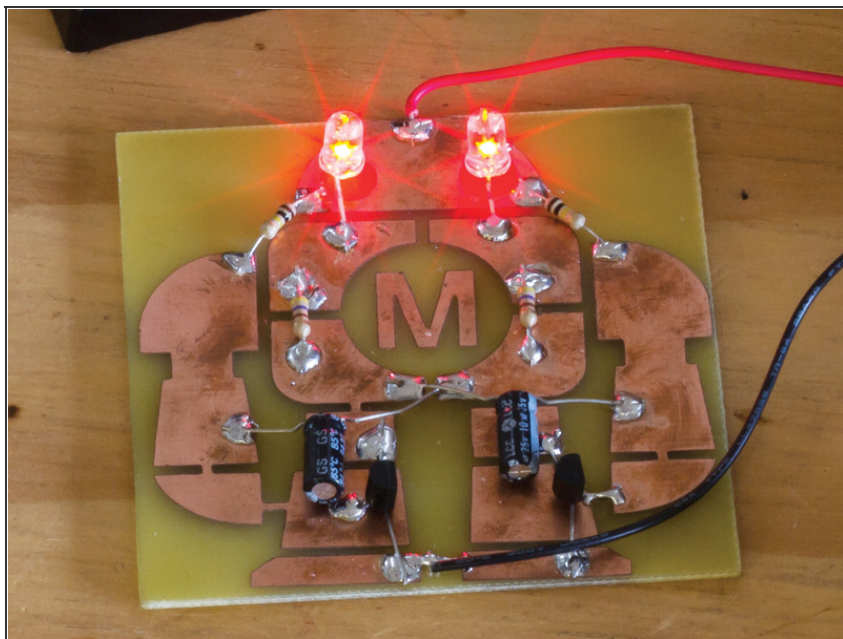
- Compare your circuit board to the original artwork. If everything is to your satisfaction, you can now drill out the holes for your components or surface mount them as we did.

- Grab this robot circuit board design at http://makezine.com/go/robotresist and etch your own. Then follow the directions there to solder a flashing-eyed robot circuit!

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